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Your Road Safety is on our RADAR.

O.T.3.1.f Pilot Actions on 4 (6) Road Safety Thematic Areas

TA3 ITS - CROATIA

RADAR – Risk Assessment on Danube Area Roads

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Internal Report Hierarchy Level			
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Abbreviation list

ITS	Intelligent Transportation System
RADAR	Risk Assessment on Danube Area Roads
SAS	Statistical Analysis System
AADT	Annual Average Daily Traffic
FPZ	Fakultet prometnih znanosti (eng. Faculty of Transport and Traffic Sciences)
PP	Project partner
ASP	Associated strategic partner

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Executive Summary

RADAR (*Risk Assessment on Danube Area Roads*) implements learning and transnational cooperation activities at different levels to help the responsible road safety organizations in the Danube area identify risk on their road networks and also helps them reduce risk systematically, by improving infrastructure and road layout. RADAR addresses all road users but pays particular attention to vulnerable road users as well as to safety on major roads near schools. It also holistically approaches the issue of safety and tackles speed as a major risk on roads.

Vehicle speed is one of the most significant factors influencing the probability of traffic accidents and the severity of their consequences. The correlation between the number of traffic accidents with fatalities and seriously injured people and the operational traffic flow speed is particularly pronounced in urban areas where, due to the presence of multiple pedestrian and bicycle crossings, intersections and road connections there are multiple points of conflict between motorized traffic and vulnerable road users. For this reason, one of the main groups of remedial measures aimed at increasing road safety includes the application of various regulatory and traffic restrictions, as well as the application of various methods and equipment for traffic calming. Based on those measures, attempts are made to reduce operational vehicle speed in traffic, and thus reduce the likelihood of traffic accidents, or mitigate the severity of the consequences in the event of their occurrence.

In recent years, the accelerated development of ITS systems and modern systems based on the application of artificial intelligence, opens new opportunities for real-time monitoring and intelligent management of traffic flows in the road network and thus achievement of a higher level of safety in the road transport system. The ITS system can be viewed as an additional subsystem of the entire transport system, or as its upgrade with which a higher level of traffic quality can be achieved without the need for extensive interventions on the design elements of road infrastructure. Road capacity as well as the level of service and safety of the road system can also be increased, and at the same time a reduction in external costs can be achieved.

The fifth Work package of the RADAR project is concerned with Road Safety Pilot Actions and its objective is to give Project partners (PPs) and Associated strategic partners (ASPs) practical experience in using the techniques and information that has been gathered in the other activities of the RADAR projects. Pilot Actions test practical procedures and tools acknowledged through the training courses and benefit of the most relevant examples that study visits selected and also test best practice and methodologies that have been discussed and selected through the work done with the RSEG and included in the Thematic Reports. The Faculty of Transport and Traffic Sciences of University of Zagreb (FPZ) is responsible for a Pilot Action on ITS for speed management.

Consequently, the subject of this research is to analyze the efficacy of an ITS system for automatic display of vehicle speeds and speed-activated traffic lights control which is already in operation on selected road sections in the Republic of Croatia. The working principle of the system is turning the red light on at the traffic light in case the vehicle is moving at a speed higher than the one configured by the system (usually the speed limit). Considering that the ITS solution in the Republic of Croatia is characteristic of isolated pedestrian crossings, for the purposes of the research, measurement of traffic flow speeds was performed at a total of six locations, whereby the locations were categorized into four types as follows:

- First type (P1) – Pedestrian crossing with horizontal and vertical signalization
- Second type (P2) - Pedestrian crossing with horizontal and vertical signalization with implemented speed display
- Third type (P3) – Signalized pedestrian crossing with a pedestrian announcement system (push button)
- Fourth type (P4) – Locations with implemented ITS system for automatic vehicle speed display and speed-activated traffic lights control.

Based on the results of collected speeds at certain locations during the characteristic days of the week, a comparative analysis was performed to determine the effectiveness of the ITS system for automatic vehicle speed display and speed-activated traffic lights control.

Following analysis results, it was found that the use of the ITS system for automatic vehicle speed display and speed-activated traffic lights control can affect the calming of the traffic flow. Also, the research shows that the presented solution contributes to the harmonization of traffic flow, which also has a positive impact on road safety.

1. ITS System

The ITS system was designed in 2008 by the Croatian company *Elektromodul-promet Ltd.* from Osijek. The goal was double-natured; to increase pedestrian safety and reduce the average vehicle speed on the road section, which consequently increased the safety of all road users on wider road section.

The first locations where the system was implemented are Čemernica and Taborište, on the section of the state road D2 Virovitica - Suhopolje (Figure 1).

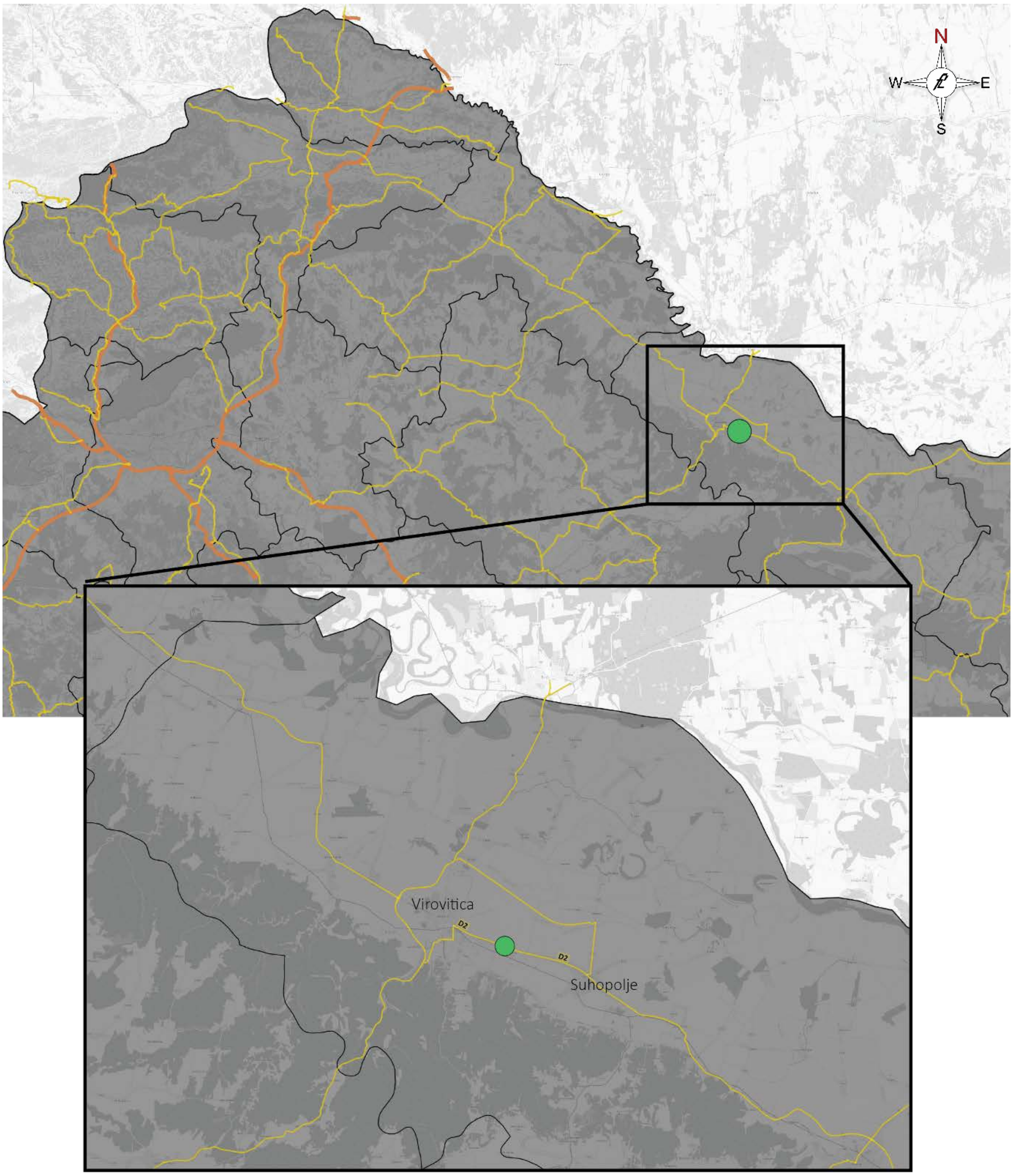


Figure 1 Location of the first implemented ITS system

Until the implementation of the ITS system, the number of accidents on the road section averaged 14 annually with 2 seriously injured and 1-2 fatalities. After implementation, the number of accidents decreased to, on average, 5 annually, with no fatalities or serious injuries. After proving successful, the ITS system began to be implemented in several locations and is now implemented in more than 60 locations in the Republic of Croatia.

The system that is the subject of this research was analyzed in two places in the Republic of Croatia, in Ljubešćica and Patkovac, at locations near schools or kindergartens, or in areas with an increased number of pedestrians, especially younger ones.

In order for the system to work, it must have the following implemented:

- Traffic lights system
- Vehicle speed radar
- Speed display

As a starting point, there is a necessity for coordination of the traffic lights system and vehicle speed radar that should be placed at a distance of 100 to 150 m from the traffic lights system.

The system works on the principle that it turns on the red light at the traffic light in case the vehicle is moving at a speed higher than the one configured by the system (speed limit/tolerated speed, etc.). Vehicle speed radars detect the speed at a great distance, and they display it with a speed display to give drivers information of their speed. If the vehicle is moving at a speed higher than the limit, the speed display gives the information with the instruction on slowing down ("SLOW"). If the vehicle continues to move at a speed higher than the one configured by the system, the traffic light, which is connected to the radar and speed display, automatically turns on the red light, forcing the vehicle to stop. It should be noted that traffic light system for pedestrians are equipped with pedestrian announcement system-push button so that pedestrians would not depend on vehicle traffic flow speed.

The schematic representation of the system operation is shown in Figure 2.

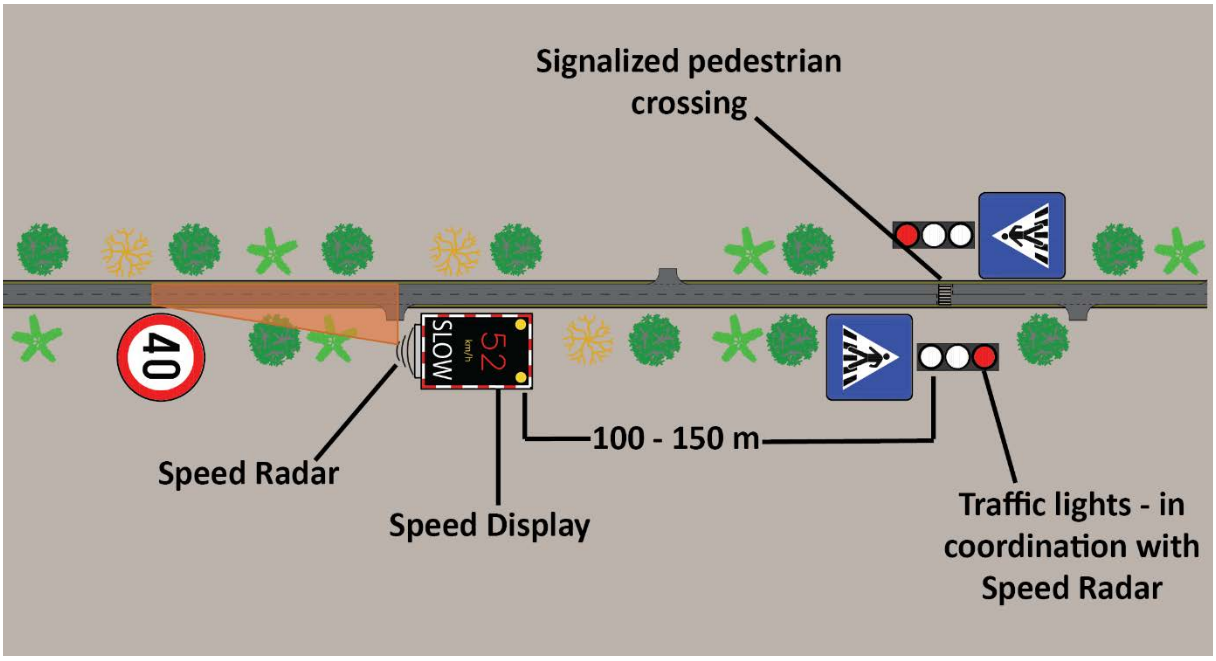


Figure 2 ITS system operation scheme

2. Methodology

For the purpose of testing the efficacy of the ITS system for automatic vehicle speed display and speed-activated traffic lights control, measurements of traffic speeds were performed both in cases where the system is or is not implemented.

The research methodology can be divided into four basic steps.

Considering that the discussed ITS solution in the Republic of Croatia is characteristic of isolated pedestrian crossings where higher collision speeds are expected, in the first step the traffic and technical characteristics of the locations where the system is implemented were analyzed. Based on the previously conducted analysis, the selection of locations with similar traffic and technical characteristics which do not have the ITS solution implemented was carried out. During the field analysis, a different way of identification of the characteristic of the location of the ITS solution was determined, so that locations, where the data collection was carried out are categorized into four basic types:

- First type (P1) – Pedestrian crossing with horizontal and vertical signalization (traffic signs ond/or raod markings)
- Second type (P2) – Pedestrian crossing with horizontal and vertical signalization with implemented speed display
- Third type (P3) – Signalized pedestrian crossing with a pedestrian announcement system (push button)
- Fourth type (P4) – Pedestrian crossing with implemented ITS system for automatic vehicle speed display and speed-activated traffic lights control (also including a pedestrian announcement system-push button).

A schematic representation of the previously listed types is given in following figures (Figure 3, 4, 5 and 6).

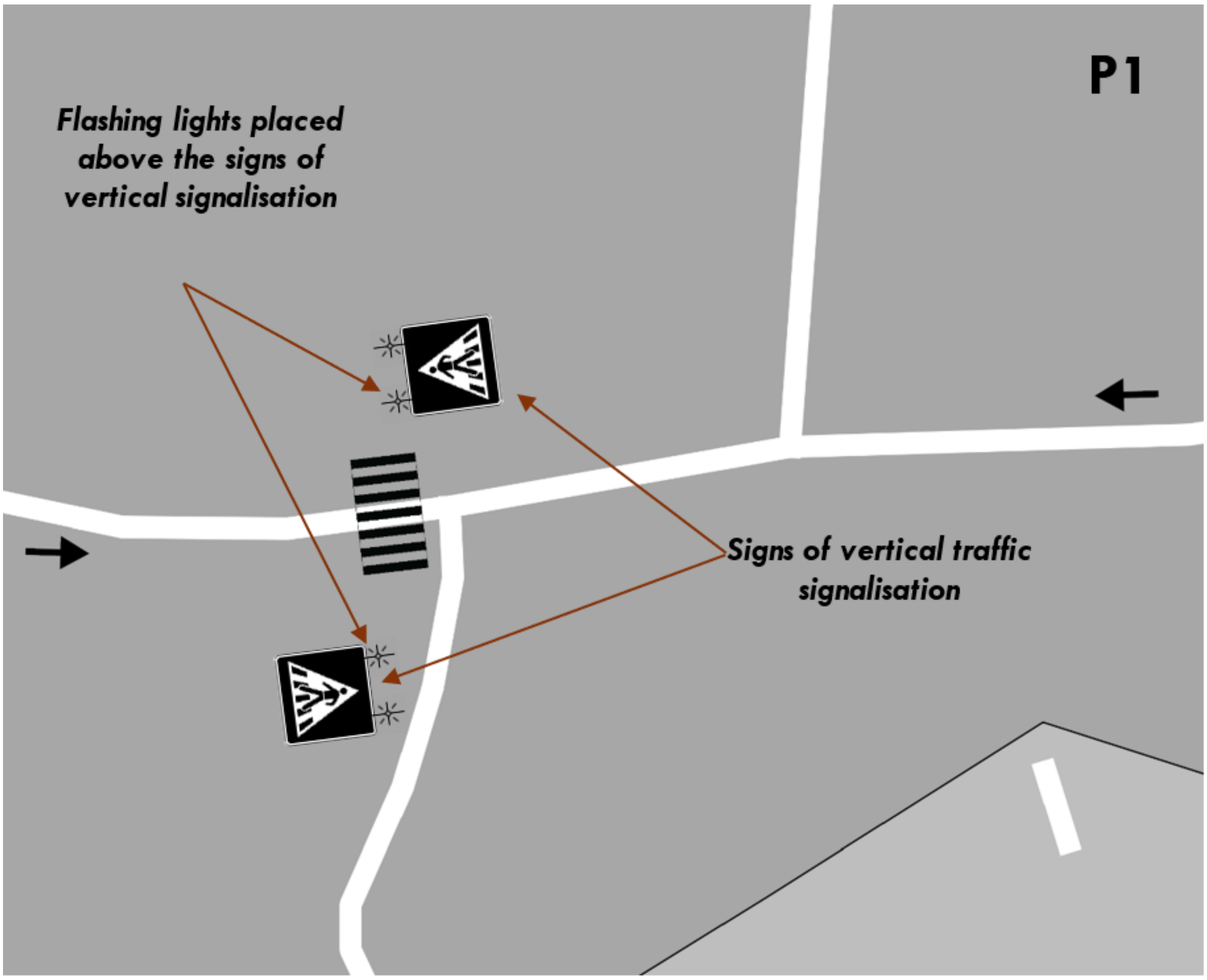


Figure 3. Type P1 location scheme

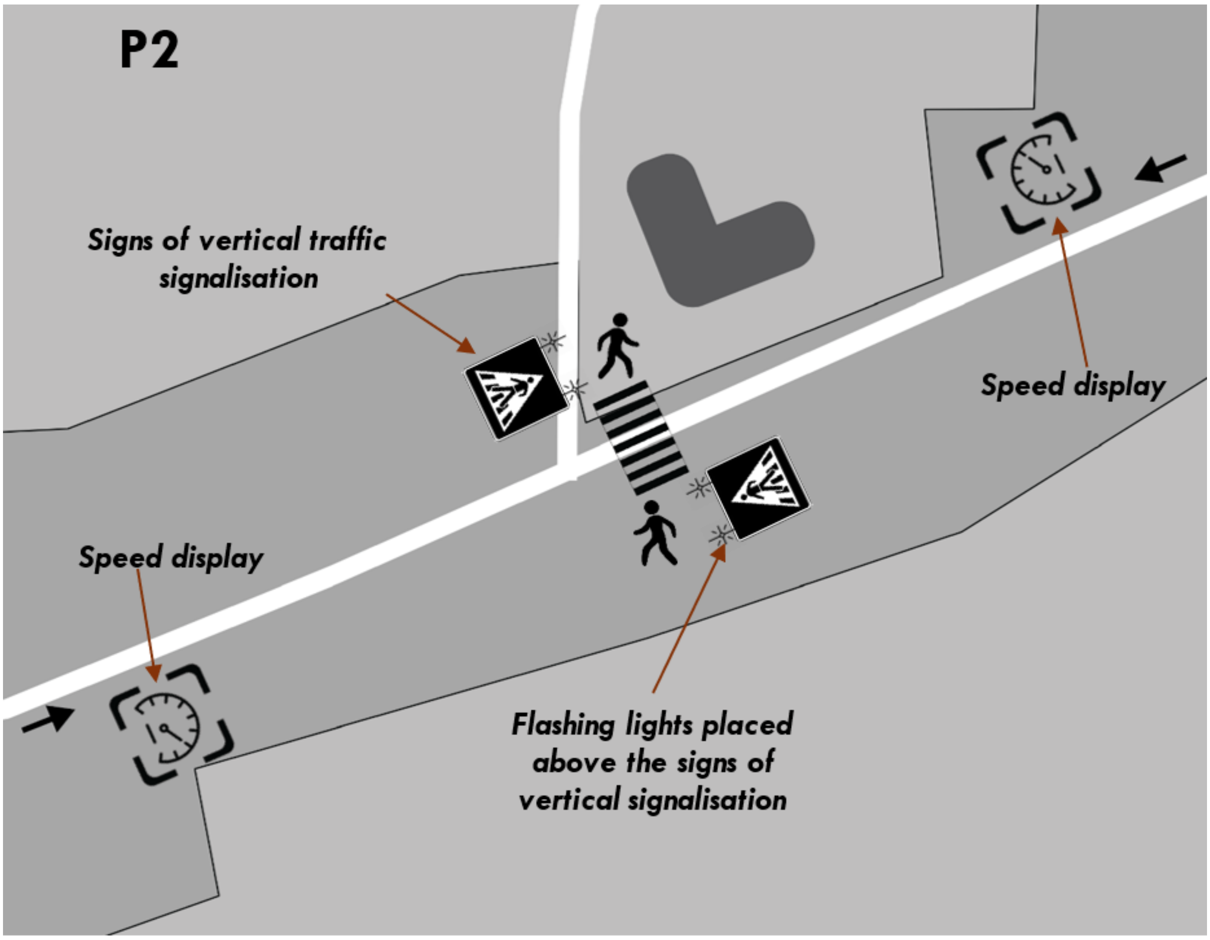


Figure 4. Type P2 location scheme

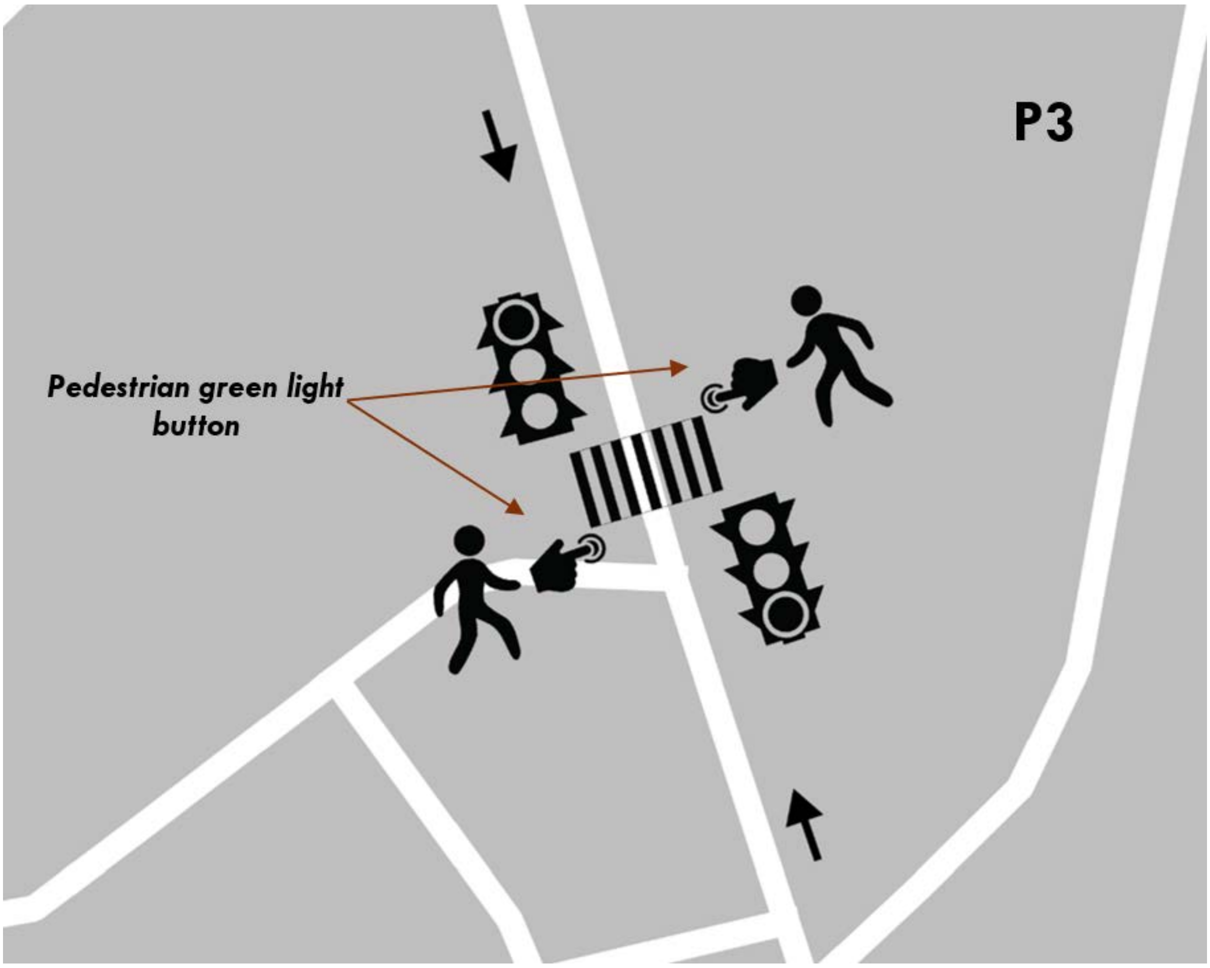


Figure 5. Type P3 location scheme

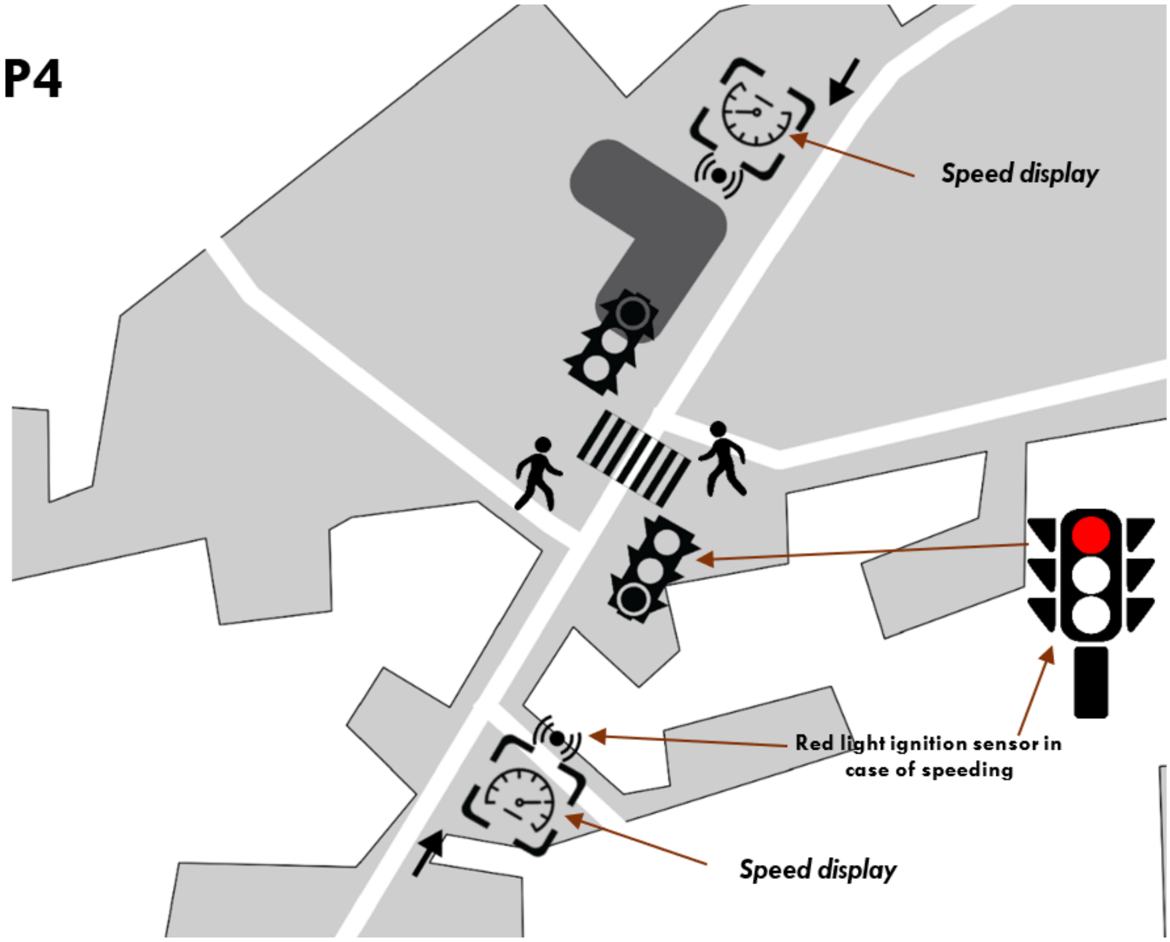


Figure 6. Type P4 location scheme

In the second step, traffic flow speed was measured at selected locations using a traffic counter during two characteristic days of the week (Wednesday and Thursday).

In the third step, the collected data on traffic flow speed was processed according to defined types. After processing, a comparative analysis of traffic flow speed according to defined types was performed in order to determine the efficacy of the ITS system for automatic vehicle speed display and speed-activated traffic lights control.

In the last, fourth step, conclusions on efficacy and guidelines for the implementation of the analyzed ITS system were presented.

A schematic representation of the methodology is given in Figure 7, while a more detailed description of the methodology is given below.

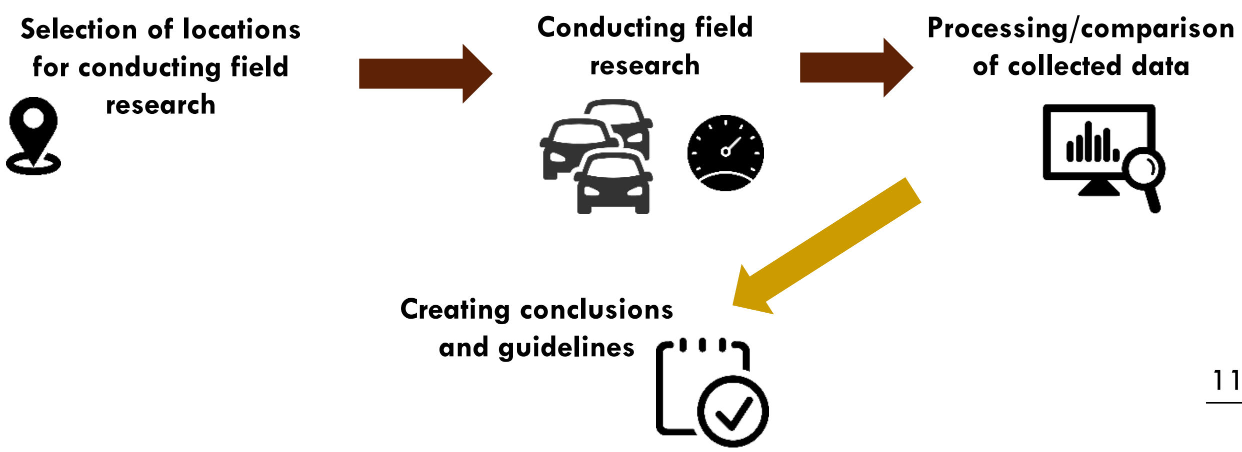


Figure 7 Methodology for investigation of the efficacy of traffic lights that regulate the ignition of red lights based on the vehicle speed

It should be mentioned that data of road and pedestrian accidents are really poor and imprecise and could mislead the study so were not included in project. Furthermore, iRAP methodology was not applied as part of research because detailed coding of road attributes would not have any impact on the outcome of the efficacy of the analysed ITS system. In addition, detailed design plans were not created due to the fact that general schematic road layout plans were designed for the four studied types of technical equipment of pedestrian crossings.

2.1. Characteristic Locations Selection

Traffic and technical characteristics analysis of locations where the ITS system for automatic vehicle speed display and speed-activated traffic lights control has already been established has determined that these locations are usually isolated pedestrian crossings and road sections where higher collision speeds are expected (e.g. urban area entrances, straight routes in an urban area).

For the purpose of the research, two locations were selected where the system was implemented and four locations where it was not. There are two P4 location types, two P1 types and one P2 and P3 location type.

An overview of the locations that are the subject of the research, according to the defined types, is given in Figure 8.

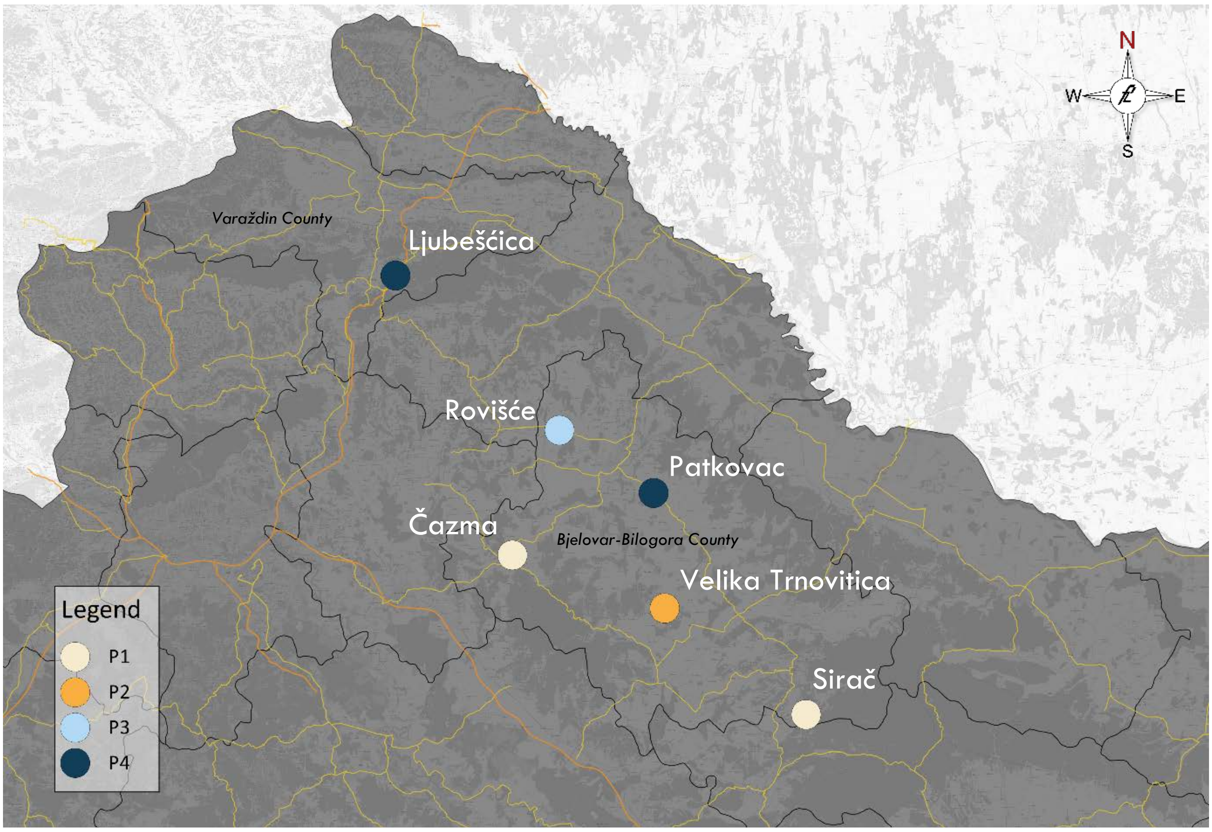


Figure 8 Locations that are the subject of the research

In order to obtain objective and credible results of comparative analysis, and thus the efficacy of the system, when selecting research sites, the condition was that they have similar traffic and technical characteristics. The analysis of basic traffic and technical characteristics according to locations including site view is shown in following tables 1, 2, 3, 4, 5 and 6).

Table 1. Basic traffic and technical characteristics of the analyzed location in Čazma

	Type	Speed limit	AADT [veh/day]	Pavement width	Urban area entrances	School zone and similar	Straight route / Curve
Čazma	P1	50 km/h	3900	6,50 m	No	No	Straight route

Table 2. Basic traffic and technical characteristics of the analyzed location in Sirač

	Type	Speed limit	AADT [veh/day]	Pavement width	Urban area entrances	School zone and similar	Straight route / Curve
Sirač	P1	50 km/h	2163	6,50 m	Yes	Yes	Straight route

Table 3. Basic traffic and technical characteristics of the analyzed location in Velika Trnovitica

	Typ e	Speed limit	AADT [veh/day]	Pavement width	Urban area entrances	School zone and similar	Straight route / Curve
Velika Trnovitica	P2	50 km/h	787	4,90 m	Yes	Yes	Straight route

Table 4. Basic traffic and technical characteristics of the analyzed location in Rovišće

	Type	Speed limit	AADT [veh/day]	Pavement width	Urban area entrances	School zone and similar	Straight route / Curve
Rovišće	P3	50 km/h	7396	5,50 m	Yes	Yes	Straight route, curve

Table 5. Basic traffic and technical characteristics of the analyzed location in Patkovac

	Type	Speed limit	AADT [veh/day]	Pavement width	Urban area entrances	School zone and similar	Straight route / Curve
Patkovac	P4	50 km/h	5521	6,50 m	Yes	Yes	Straight route, curve

Table 6. Basic traffic and technical characteristics of the analyzed location in Ljubešćica

	Type	Speed limit	AADT [veh/day]	Pavement width	Urban area entrances	School zone and similar	Straight route / Curve
Ljubešćica	P4	40 km/h	2849	6,50 m	Yes	Yes	Straight route, curve

2.2. Traffic Flow Speed Data Collection

Traffic flow speed data collection was carried out using automatic traffic counters that record information about the time, speed and length of the vehicle. The measurement was performed over two characteristic days during the week (Wednesday and Thursday).

For the purposes of the measurement, it was important to determine the exact measurement positions at a particular location (similar technical elements of the road, distance from the pedestrian crossing, etc.) in order to obtain comparable results. According to the above, the exact position of traffic speed measurement at a particular location is defined in such a way that it corresponds to the position at which the ITS system detects the operating vehicle speed and regulates the status of the traffic light device. In practice, this was a distance of 100 to 150 meters from the pedestrian crossing, depending on the specifics of the location and the legally regulated speed limit.

It is also important to note that when collecting data, traffic load, vehicle lengths and vehicle speeds were measured for both driving directions, while the vehicle speed analysis was performed only for the "inbound" traffic direction (it is considered that vehicle speeds tend to be higher when entering into urban zone area from an extra-urban, country road).

An overview of the images of the used automatic traffic counters and their placement is given in Figure 9.

Figure 9 Automatic traffic counters installation

2.3. Data Processing

The processing of the collected data was performed using the SAS statistical tool according to the following steps:

1. Downloading the raw data from a traffic counter.

2. Determining atypical values of data collected at a particular location, according to two categories: speed and length of the vehicle, and in such a way that all values of speed and length that could not be logically explained (e.g. speed 140 km/h, and length greater than 40 m) were not used in processing. Less than 1% of such values were recorded at each location.

3. Analytical and graphical comparison of average hourly speed by location type.

4. Implementation of descriptive statistics of measured speed according to location type.

5. Determining a statistically significant difference in average hourly speeds by location type.

6. Interpretation of the obtained results.

When processing and understanding the results, it is important to note that fine tolerance of + 10 km/h is present within traffic regulations in the Republic of Croatia, which means that driver would not be fined if driving, for instance, 70 km/h in 60 km/h limit zone (the tolerance of +10 km/h refers to speed limits below 100 km/h).

2.4. Research Results

In the last step of the research, the level of efficacy of the ITS system for automatic vehicle speed display and speed-activated traffic lights control was determined based on the established results of descriptive and inferential statistics. Guidelines for the use and implementation of the analyzed ITS system intending to increase traffic safety were also developed.

3. Research Results

As previously mentioned, the field research included a total of six locations where vehicle speed was measured over a period of two full characteristic days of the week (Wednesday and Thursday).

In the continuation of the chapter, the results of the speed analysis by location type are presented, as follows:

- graphical speed analysis per certain type
- descriptive speed analysis per certain type
- determination of a statistically significant difference in the speed average per certain type.

3.1. Graphical Speed Analysis

3.1.1. Pedestrian Crossing with Horizontal and Vertical Signalization (P1)

Pedestrian crossings with horizontal and vertical signalization were analyzed at two locations, Čazma and Sirač. Chart 1shows the average hourly speeds at pedestrian crossings of category P1, which are marked by horizontal and vertical signalization. It should be mentioned that traffic load in Čazma is almost twice comparing to the one in Sirač. Furthermore, the analyzed location in Sirač is set in urban area whereas the one in Čazma is set outside of urban area, at the entrance of urban area.

The chart shows that the maximum average hourly speed is 67 km/h, which is 17 km/h above the speed limit and 7 km/h above the tolerated speed. It should also be noted that even the minimum average hourly speed of the vehicle (54 km/h) exceeds the speed limit (50 km/h).

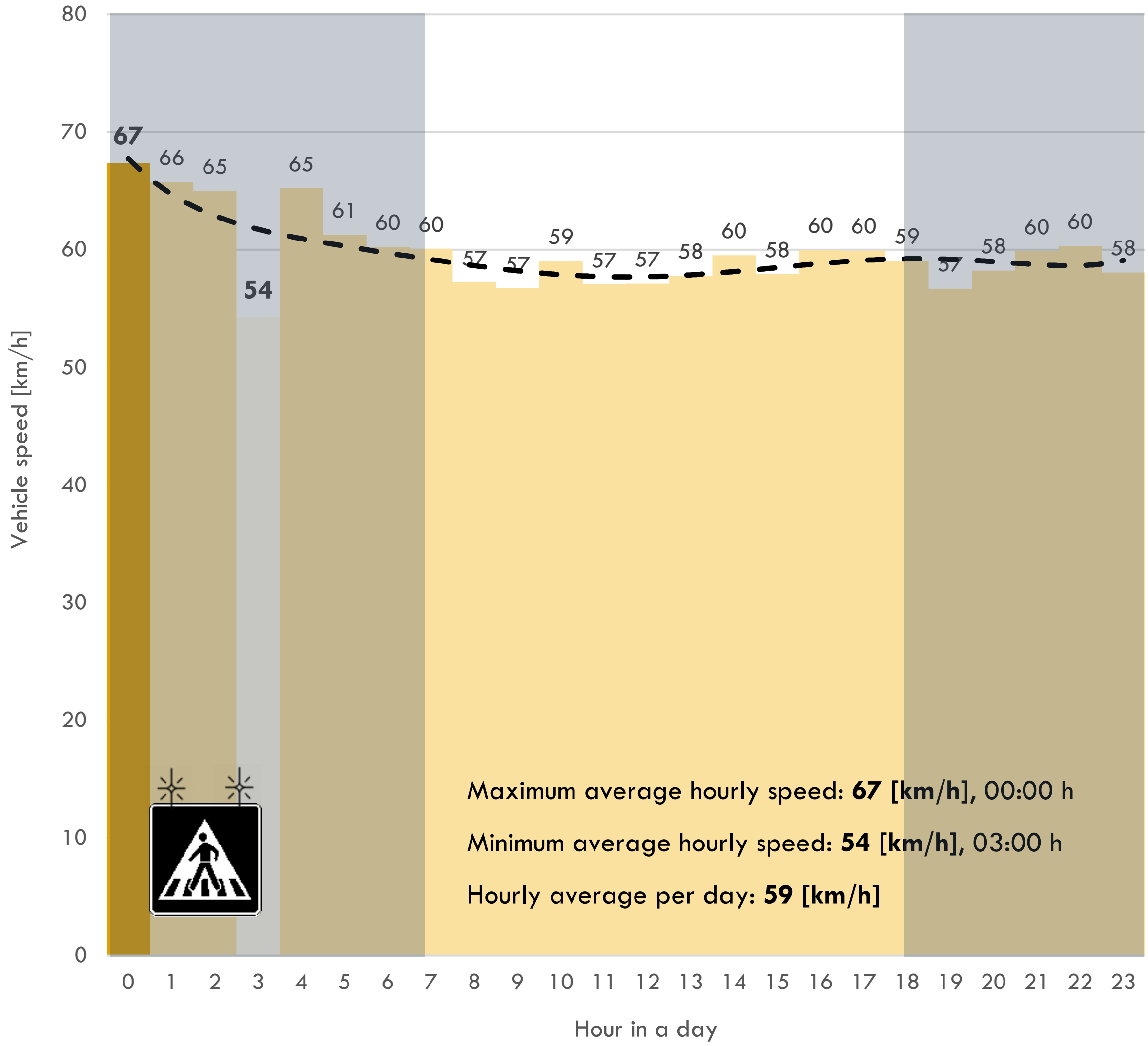


Chart 1 The average hourly speed at pedestrian crossings marked with horizontal and vertical signalization (P1)

3.1.2. Pedestrian Crossing with Horizontal and Vertical Signalization with Implemented Speed Display (P2)

A pedestrian crossing marked with horizontal and vertical signalization with implemented speed display for both driving directions was analyzed in Velika Trnovitica. The research determined a significantly higher maximum average hourly vehicle speed compared to the previously described type of pedestrian crossing, which was 80 km/h as well as the hourly average on the day which was 63 km/h. The minimum average hourly speed is 56 km/h, which is also an important fact considering the speed limit of 50 km/h and the tolerated speed of 60 km/h.

The average hourly speed at pedestrian crossings marked with horizontal and vertical signalization with implemented speed display for both directions are shown in Chart 2.

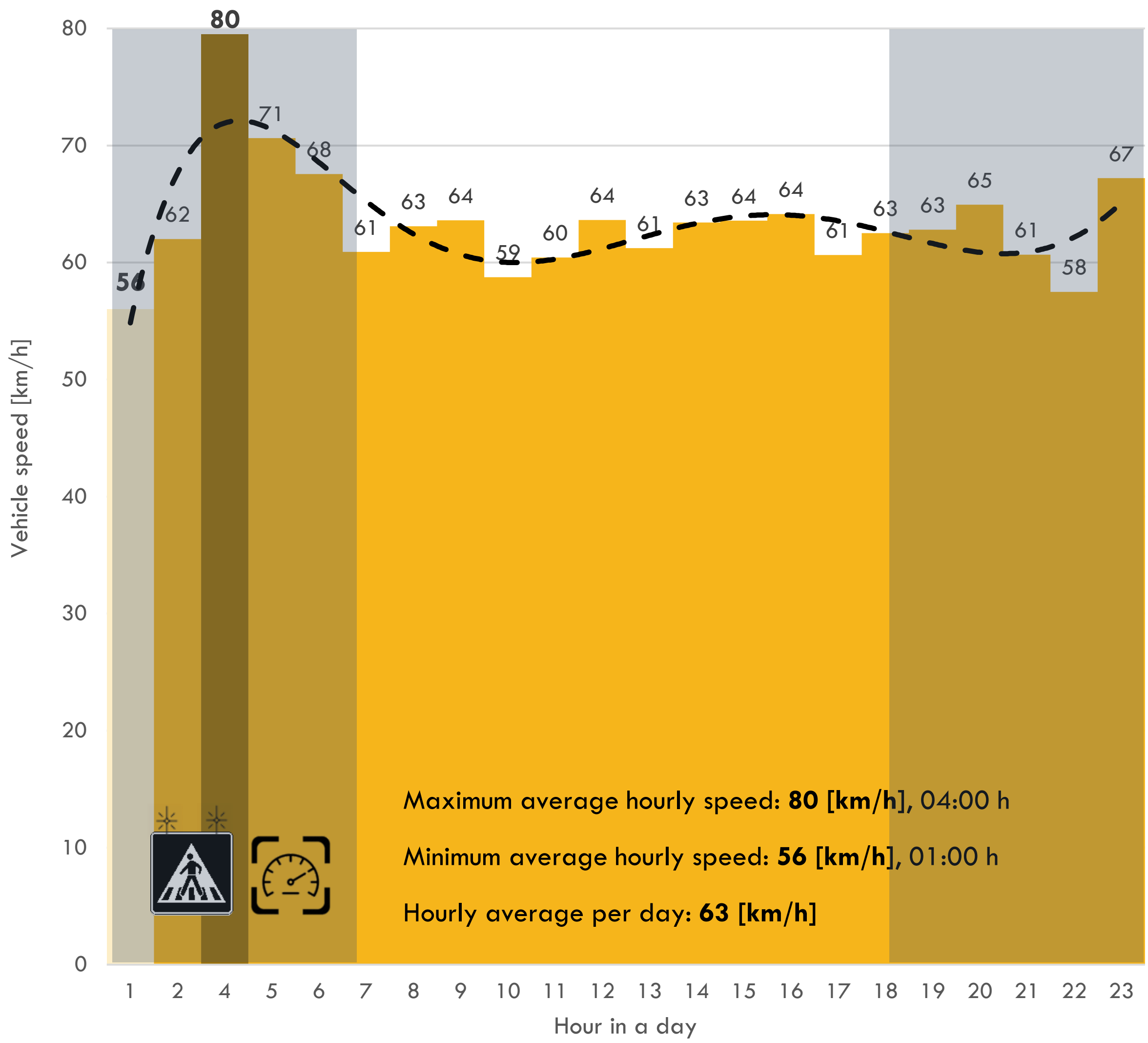


Chart 2 The average hourly speed at pedestrian crossings marked with horizontal and vertical signalization with implemented speed display (P2)

3.1.3. Signalized Pedestrian Crossing with a Pedestrian Announcement System (P3)

A signalized pedestrian crossing with a pedestrian announcement system using pushbuttons was analyzed in Rovišće. Unlike the previously described two types of pedestrian crossings, lower vehicle speed was recorded at this type of crossing, so the highest average hourly speed was 63 km/h, and the lowest 44 km/h. It is important to note that the hourly average per day speed is only slightly higher than the speed limit and lower than the tolerated speed.

Chart 3 shows that the average hourly speed is lower during the day, possibly as a result of a larger number of pedestrian traffic requests, which results in stopping the flow of vehicles, i.e. lower speed.

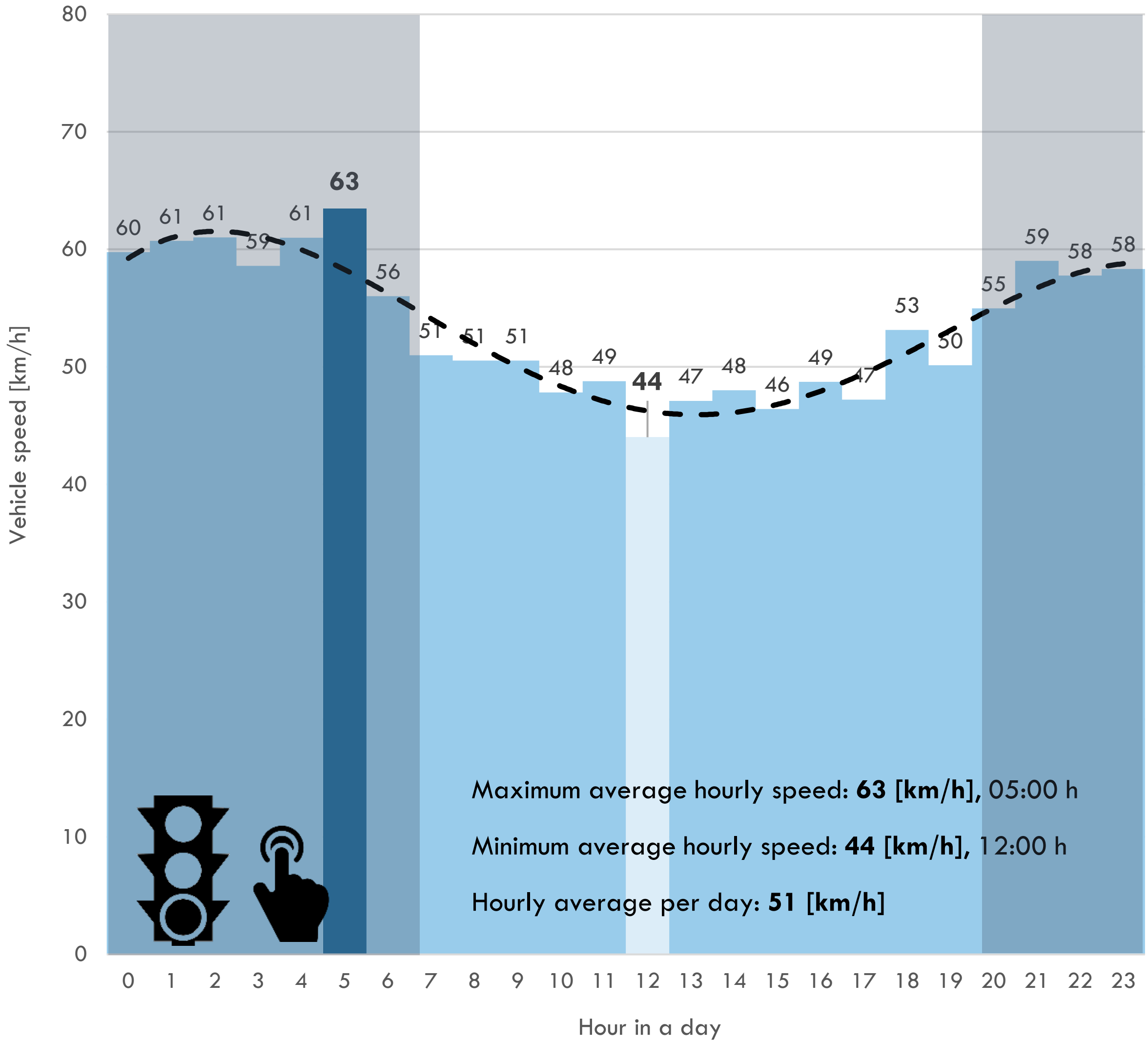


Chart 3 The average hourly traffic speed at a signalized pedestrian crossing with a pedestrian announcement system (P3)

3.1.4. Pedestrian Crossing with Implemented ITS System for Automatic Vehicle Speed Display and Traffic Lights Control (P4)

Pedestrian crossings with implemented ITS system for automatic vehicle speed display and traffic lights control was analyzed at two locations, Ljubešćica and Patkovac. It should be mentioned that traffic load in Patkovac is almost twice comparing to the one in Ljubešćica. However, both locations are set at similar locations considering urban area and school/kindergarten presence nearby the site.

As for the previously analyzed signalized pedestrian crossings (P3), average hourly vehicle speed was lower compared to the analyzed non-signalized crossings (P1 and P2). The highest average hourly speed was 58 km/h, the lowest 52 km/h and the hourly average was 53 km/h.

Chart 4 shows that lower values of vehicle speed were recorded throughout the day. During the night, the average speed is slightly higher as a result of a smaller number of vehicles, and these are drivers who violate the regulations and are then stopped by a red light.

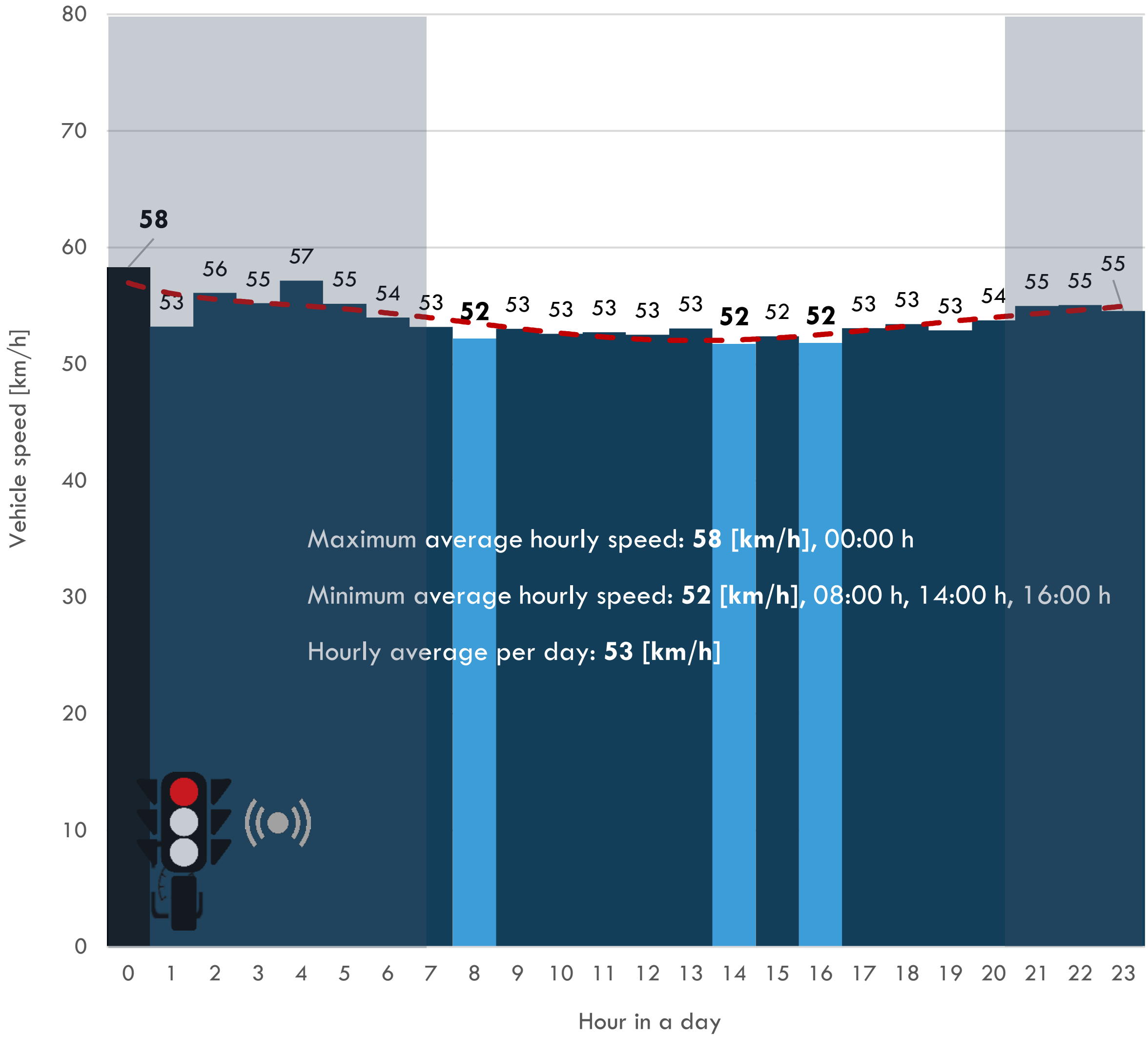


Chart 4 The average hourly speed at pedestrian crossings with implemented ITS system for automatic vehicle speed display and traffic lights control (P4)

3.1.5. Concluding Remarks

After conducting the analysis of all four types of pedestrian crossings it is obvious that categories P1 and P2 have significantly higher values of average vehicle speed throughout the day. It is also an interesting fact that P2 records higher values of average vehicle speed, when comparing to P1, despite being equipped with speed displays, however, they have been implemented for a longer period of time and it can be assumed that such systems are less efficacious after a certain period of time. Consequently, in such systems it is necessary to encourage more frequent relocation as well as linking with the possibility of penalisation in case of speeding.

When comparing to non-signalized pedestrian crossings (P1 and P2), P3 and P4, as can be seen in Chart 5, record lower values of average vehicle speed. There could be more than one factor for the previously mentioned fact: pedestrian crossing equipment, AADT, vehicle type distribution, urban/extra-urban area, nearby presence of school/kindergarten, road width, longitudinal road slope, etc.

Although it cannot be concluded that the ITS system has an impact on reducing vehicle speeds, it is safe to assume that presence of traffic lights at a pedestrian crossing might have a positive impact on pedestrian safety.

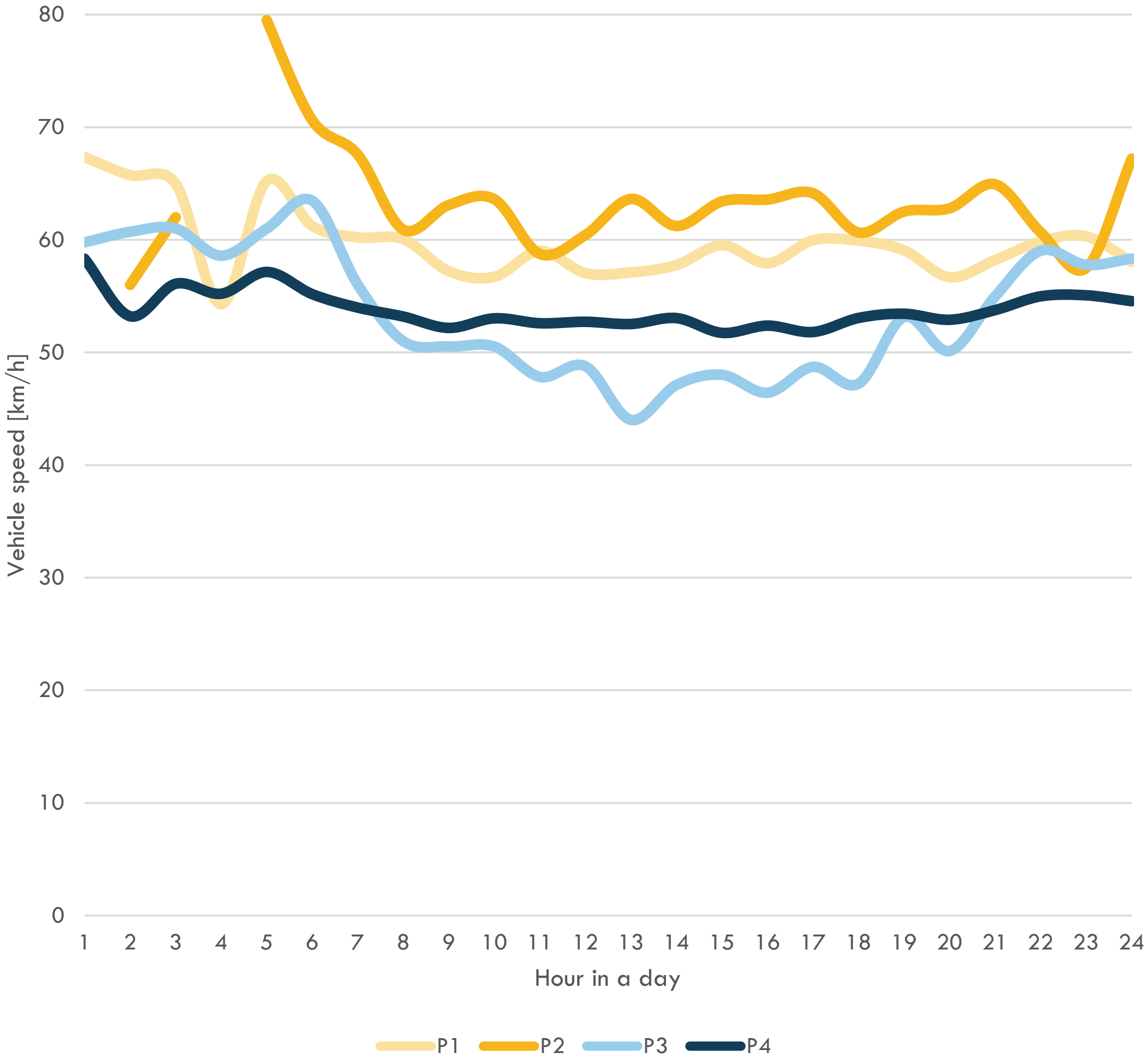


Chart 5 Speed comparison of all analyzed types of pedestrian crossings

3.2. Descriptive Speed Statistics

With the aim of better analysis of the determined differences in a traffic flow speed, and depending on the location type, a descriptive statistics analysis was performed.

The total sample on which the survey is based is 27,628 vehicles. The display of the sample size by individual category is shown in Chart 6. It is worth noting that types P1 and P4 were analyzed on two locations whereas type P2 only on one, which is the reason for such a small number of samples (especially when taking into account a modest AADT; Rovišće (P3) recorded the highest AADT of all locations).

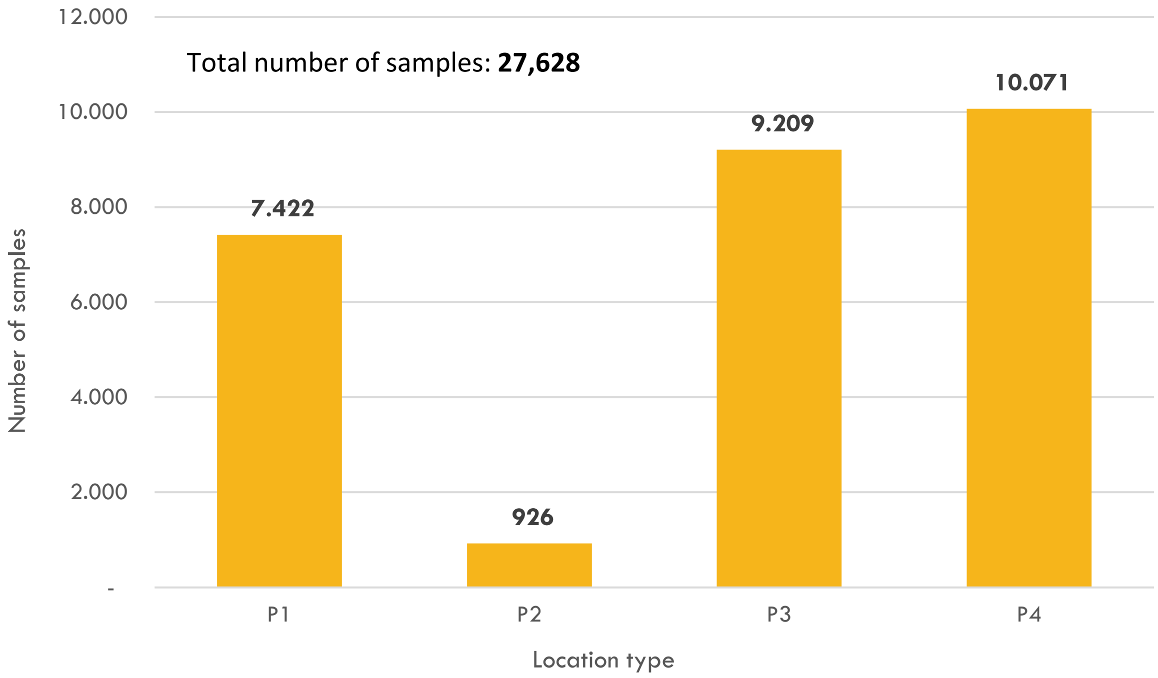


Chart 6 Number of samples by the pedestrian crossing type

If one considers the average and median speed per individual category, it is clear that there is no substantial difference between the average and median traffic speed per individual location. As determined by graphical analysis, the lowest value of average speed was recorded in categories P4 and P3, followed by P1 and P2. The results are shown in Chart 7.

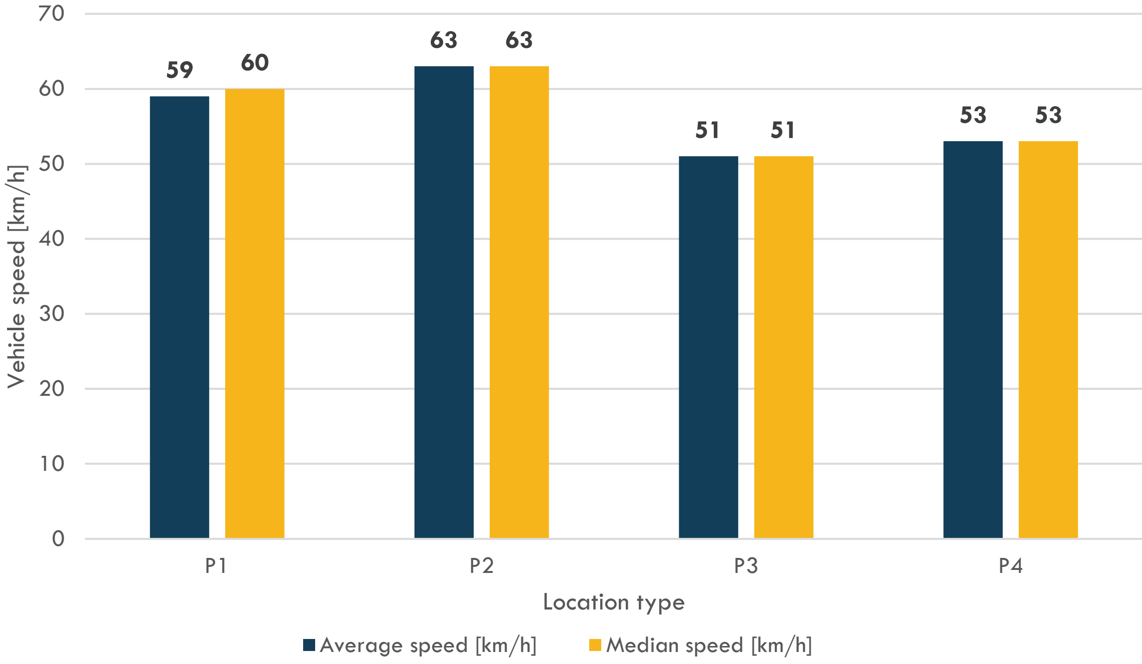


Chart 7 Average and median speed analysis

According to average and median speed analysis, the analysis of 85-percentile speed showed that at locations with implemented ITS traffic calming system, the 85-percentile speed is lower by an average about 17-22% than categories P1 and P2 and about 2% than category P3.

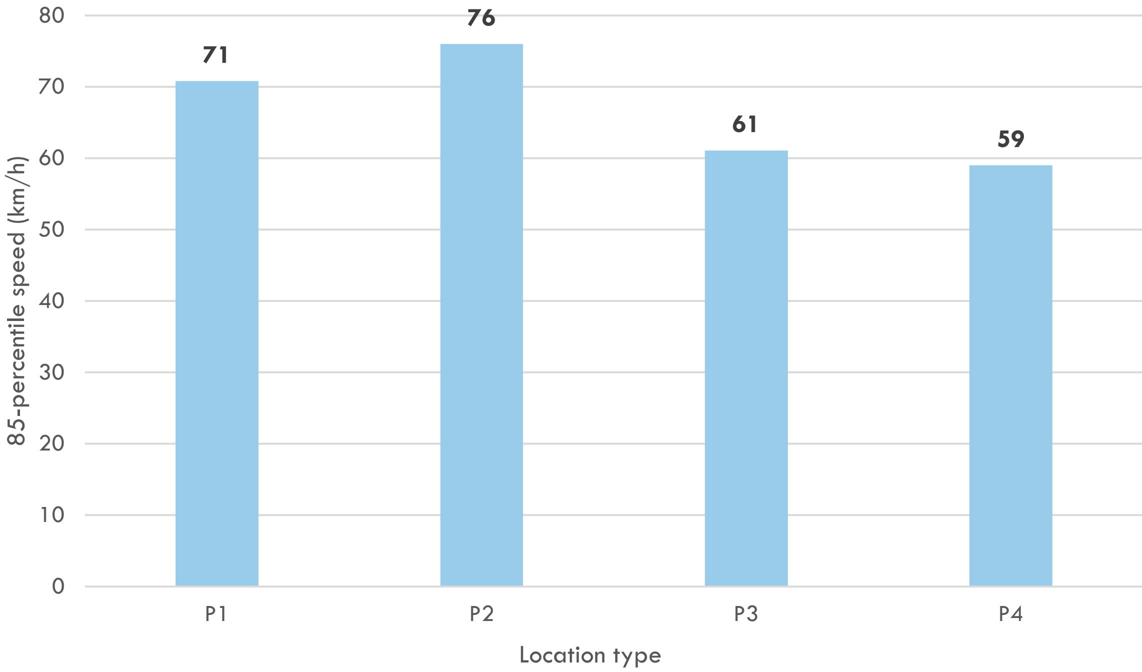


Chart 8 85-percentile speed analysis

If the standard deviation is analyzed, the minimal deviation of the traffic speed was recorded at the P4 locations that have implemented the ITS system for automatic display of vehicle speed and speed-activated traffic lights control. The standard deviation is 30 to 35% smaller compared to categories P1 and P2 and 25% compared to category P3. This indicates a better harmonization of traffic flow speed by implementing the ITS system in relation to all other types that are the subject of the research. The presentation of the results of the standard deviation per individual type is shown in Chart 9.

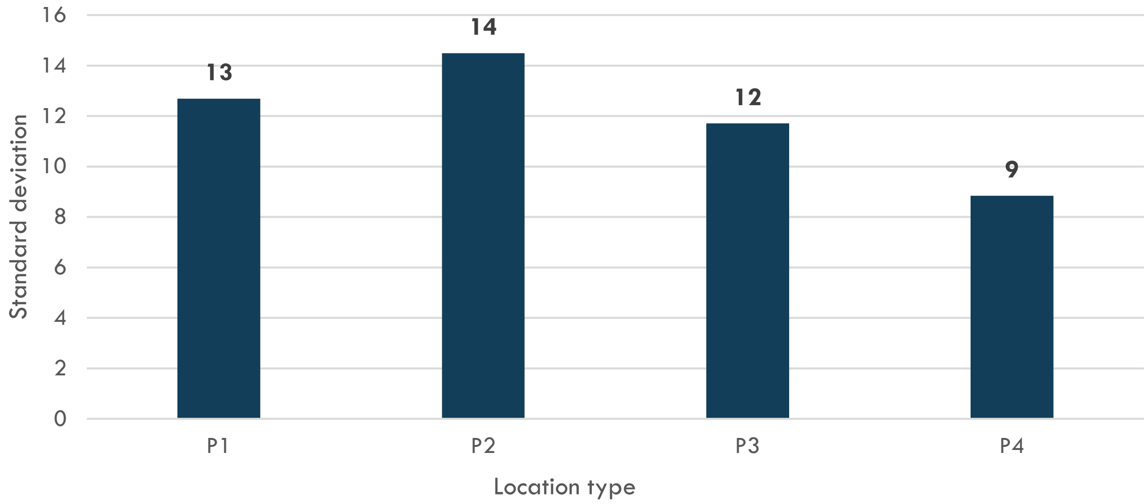
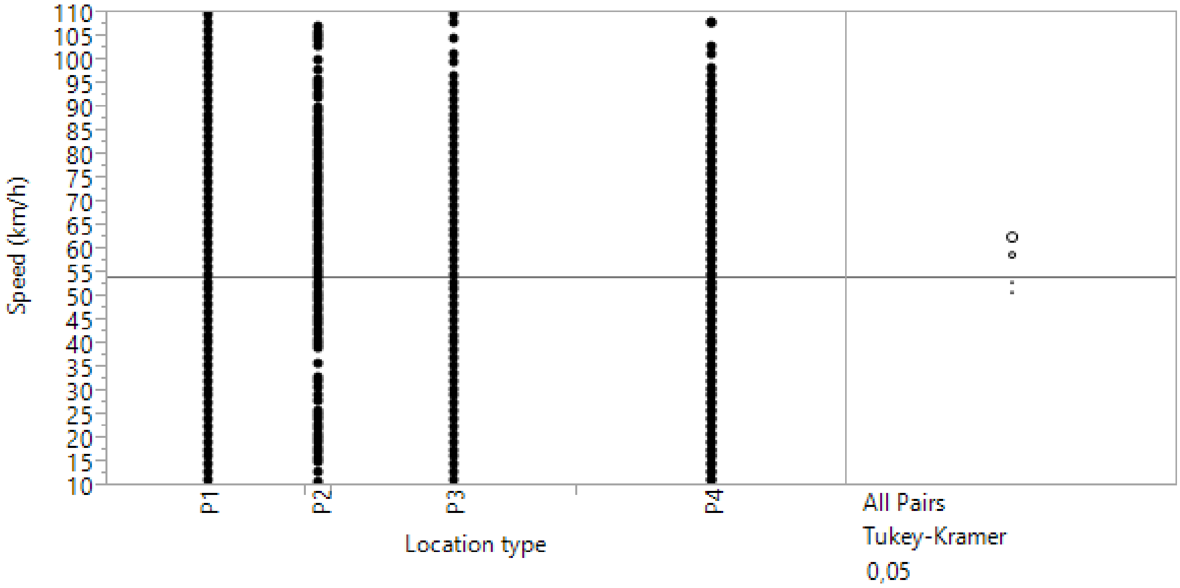


Chart 9 Display of the standard deviation of each pedestrian crossing type

3.3. Statistical Difference in Average Speed

In order to determine the statistical significance of the difference in the average traffic speed per certain type, the analysis of the difference in the average speed was performed using the Tukey-Kramer test[1]. The results revealed the existence of a statistically substantial difference in speed per location type, which is in accordance with the conclusions of the graphical analysis of the obtained results and the descriptive statistic results. The results of the test are shown in Chart 10.

[1] The Tukey-Kramer test is a multiple comparison test that can find means that are significantly different.



Comparisons for all pairs using Tukey-Kramer HSD

Confidence Quantile

q*	Alpha
2,56919	0,05

LSD Threshold Matrix

Abs(Dif)-HSD

	P2	P1	P4	P3
P2	-1,332	2,773	8,568	10,877
P1	2,773	-0,470	5,342	7,646
P4	8,568	5,342	-0,404	1,899
P3	10,877	7,646	1,899	-0,422

Positive values show pairs of means that are significantly different.

Connecting Letters Report

Level					Mean
P2	A				62,602592
P1		B			58,830735
P4			C		53,050013
P3				D	50,737425

Levels not connected by same letter are significantly different.

Ordered Differences Report

Level	- Level	Difference	Std Err Dif	Lower CL	Upper CL	p-Value
P2	P3	11,86517	0,3845839	10,87710	12,85324	<,0001*
P2	P4	9,55258	0,3830772	8,56838	10,53678	<,0001*
P1	P3	8,09331	0,1740137	7,64624	8,54038	<,0001*
P1	P4	5,78072	0,1706579	5,34227	6,21917	<,0001*
P2	P1	3,77186	0,3887910	2,77298	4,77073	<,0001*
P4	P3	2,31259	0,1608429	1,89935	2,72582	<,0001*

Chart 10 Analysis of the difference in the average traffic flow speed per location type

4. Concluding Remarks and Guidelines

Based on the research on the effectiveness of the ITS system for automatic vehicle speed display and speed-activated traffic lights control, measurements of traffic speeds were carried out at different locations where the system is or isn't implemented. In order to increase the quality of results and proper understanding of the effectiveness of the ITS system, the study included four different categories of traffic flow management in seemingly similar traffic situations as well as traffic and technical characteristics of the road. The research was related to the regulation of traffic in the zone of isolated pedestrian crossings where, as a rule, higher speeds are expected (e.g. urban area entrances, straight routes in urban areas, etc.).

Statistical analysis of the collected results on traffic flow speed established the following:

- The highest hourly average speeds per day were recorded in the pedestrian crossing zones marked only by horizontal and vertical signalization with or without speed display (P1 and P2). At the locations with those types of pedestrian crossings were also recorded the highest maximum average hourly speeds (comparing to locations with categories P3 and P4)
- At the location with the signalized pedestrian crossing which includes a pedestrian announcement system (P3), smaller hourly average speeds per day and smaller maximum average speeds were recorded when comparing to locations with categories P1 and P2, especially during the day when there is substantial pedestrian activity. During the evening and morning hours when there is no walking activity, speeds are substantially higher. According to previously mentioned, it is obvious that pedestrian flows (pedestrian announcement system) do affect vehicle speeds nearby the pedestrian crossings.
- Pedestrian crossings with implemented ITS system for automatic vehicle speed display and traffic lights control (P4) substantially affect the calming of traffic speeds throughout the day. The 85-percentile speed analysis showed that at locations with implemented ITS traffic calming system, the 85-percentile speeds are, in average, about 17-22% lower compared to locations with categories P1 and P2 and about 2% when it comes to the location with type P3. When analyzing standard deviation, the smallest deviation of the traffic flow speed was recorded at the locations which have implemented ITS system for automatic vehicle speed display and speed-activated traffic lights control (P4). The standard deviation is 30 to 35% lower compared to categories P1 and P2 and 25% compared to category P3. This indicates a more substantial harmonization of traffic flow speed by implementing the ITS system in relation to all other situations which are the subject of the research. Statistical significance was also determined for the previously described results.

In accordance with the conclusions from the research, it can be concluded that average speeds were the lowest at locations with ITS system for automatic vehicle speed display and speed-activated traffic lights control. Lower speeds may have an impact on traffic calming and to the harmonization of traffic flow, which has a positive impact on traffic safety, especially on pedestrian safety.

Finally, it should be noted that the conducted research cannot be stated as before & after study due to several limitations. Primarily, it was quite difficult to approach the before study because the lack of vehicle speeds data before the ITS system implementation. It is also not known whether there is going to be implementation at other locations. Also, data of road and pedestrian accidents are really poor and imprecise and could mislead the study. Furthermore, similarity between P1 and P2 is evident, however, very few of such locations were taken into account when analysing.

Despite the above, this study, as well as other's experience have shown that the ITS system could be a good solution for traffic calming at specific locations; urban zone entrances where higher vehicle speeds are expected. The ITS system could also be beneficial at isolated pedestrian crossings where pedestrian safety is potentially jeopardized. To conclude, there are many locations in and outside urban areas where pedestrian are potentially endangered and where simple system such as the one analysed can be the best solution and which will hopefully be shown through further analysis.